

THE MERCK INDEX

AN ENCYCLOPEDIA OF
CHEMICALS, DRUGS, AND BIOLOGICALS

THIRTEENTH EDITION

Editorial Staff

Maryadele J. O'Neil, *Senior Editor*

Ann Smith, *Senior Associate Editor*

Patricia E. Heckelman, *Associate Editor*

John R. Obenchain Jr., *Editorial Assistant*

Jo Ann R. Gallipeau, *Technical Assistant*

Mary Ann D'Arecca, *Administrative Associate*

Susan Budavari, *Editor Emeritus*

*Published by
Merck Research Laboratories
Division of*

MERCK & CO., INC.
Whitehouse Station, NJ

2001

BEST AVAILABLE COPY

MERCK & CO., INC.

Whitehouse Station, NJ

USA

1st Edition—1889
2nd Edition—1896
3rd Edition—1907
4th Edition—1930
5th Edition—1940
6th Edition—1952
7th Edition—1960
8th Edition—1968
9th Edition—1976
10th Edition—1983
11th Edition—1989
12th Edition—1996

Library of Congress Catalog

Card Number 89-60001

ISBN Number 0911910-13-1

Copyright © 2001 by MERCK & CO., INC.
All rights reserved. Copyright under the Universal Copyright Convention
and the International Copyright Convention.
Copyright reserved under the Pan-American Copyright Convention.

Printed in the USA

BEST AVAILABLE COPY

ral acids. Aq
-70°; reduced

mpn.

5-1] Cobalto-
s. Co_3O_4 ; mol
elin's, *Cobalt*
ent, 202, 491-
3-13; 16, 3-15

stem. d 6.11.
out 71% Co.
t lower temps
but no definite
Co metal by C,
ds, alkalies.
ing wheels.

Cobalt trifluo-
%. Prepn from
3. *Syn.* 3, 175
organic Chem-
New York, 2nd
, Kukul, *J. Am.*

1.88. Discolors
water giving off
uorine pressure
in an F_2 stream
ed glass, quartz.

ly for complete
cess.

2016-80-7] Co-
ho H_2O ; mol wt
(OH). Alternate
book of Prepar-
Ed. (Academic
1; Schrader, Per-
7). Existence of
established: Pa-
Nicholls in *Com-*
Bailar, Jr. et al.
See also de Bie,
der, Petzold, loc.
(1969).
crystal structure.
a vacuum. Prac-
 Cl_2 ; sol in HNO_3 .

obalt from nickel.

782-01-9] Hexa-
tassium hexani-
tassium nitroco-
C.I. Pigment Yel-
2.26. Co 13.03%.
 $(\text{O}_2)_6$. Incorrectly
of KNO_2 to a so-
m. 32, 548 (1962).
c crystals. Very
ly insol in alcohol.

n painting on glass
on of Co from Ni:

$\text{C}_2\text{H}_4\text{CoO}_4$; mol wt
36.15%. $\text{Co}(\text{C}_2\text{H}_3\text{O}_2)_2$
dioxide or carbon-
tal in *Kirk-Othmer*
(Interscience, New
dered Co and acetic
prepn by oxidation
acid: Gwynn et al.

US 3246024 (1966 to Gulf). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Light-pink crystals. Readily sol in water.

Tetrahydrate. Bis(acetato)tetraaquocobalt. Intense red, monoclinic, prismatic crystals. d 1.705. On heating becomes anhydrous by 140°. Sol in water, alcohols, dil acids, pentyl acetate. pH of 0.2 molar aq soln 6.8.

USE: Bleaching agent and drier for lacquers, varnishes; in anodizing; catalyst for oxidation and esterification; foam stabilizer for malt beverages.

2459. Cobaltous Arsenate. [7785-24-2] C.I. 77350. $\text{As}_2\text{Co}_3\text{O}_8$; mol wt 454.64. As 32.96%, Co 38.89%, O 28.15%. $\text{Co}_3(\text{AsO}_4)_2$. Octahydrate occurs in nature as *erythrite* or *cobalt bloom*. Prepn: *Gmelin's, Cobalt* (8th ed.) 58, (part A), 305 (1932) and supplement, 752 (1961); Charles-Messance et al., *Bull. Soc. Chim. France* 1962, 574. See *Colour Index* vol. 4 (3rd ed., 1971) p 4664.

Octahydrate, pink to blood-red, monoclinic, fine needles. On heating becomes anhyd by 400°. Dec by 1000° to $\text{Co}_6\text{As}_2\text{O}_{11}$. d 2.9-3.1. Practically insol in water. Sol in dil mineral acids, in NH_4OH .

USE: Painting on glass and porcelain.

2460. Cobaltous Bromide. [7789-43-7] Cobalt dibromide. Br_2Co ; mol wt 218.74. Br 73.06%, Co 26.94%. CoBr_2 . Prepn of hexahydrate from CoCO_3 and HBr : Clark, Buchner, *J. Am. Chem. Soc.* 44, 230 (1922). Prepn of anhydr. *idem*, loc. cit.; Watt et al., *ibid.* 77, 2752 (1955); Wydeven, Gregory, *J. Phys. Chem.* 68, 3249 (1964).

Bright green solid or lustrous green cryst leaflets. mp 678° (under HBr and N_2); d_4^{25} 4.909. Hygroscopic, forms hexahydrate in air. Readily sol in water, methanol, ethanol, acetone, methyl acetate.

Hexahydrate. Red to reddish-purple, deliquesce, prismatic crystals. mp 47-48°. d_4^{25} 2.46. Loses $4\text{H}_2\text{O}$ at 100° giving the purple dihydrate, and all H_2O by 130°. Sol in water giving red or blue soln depending on concn and temp, in methanol giving red soln, in ethanol, acetone, ether, methyl acetate giving blue solns. Keep well closed.

USE: Chiefly in hygrometers; also in catalysts for organic reactions.

2461. Cobaltous Carbonate. [513-79-1] CCoO_3 ; mol wt 118.94. C 10.10%, Co 49.55%, O 40.35%. CoCO_3 . Occurs in nature as the mineral *cobalt spar* or *sphaerocobaltite*. Prepd by heating a soln of a cobaltous salt with Na_2CO_3 : Schlessinger, *Inorg. Syn.* 6, 189 (1963) where it is the starting material for the prepn of trinitrotri-aminocobalt. Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Red powder or rhombohedral crystals. d 4.13. Almost insol in water, alcohol, methyl acetate. Does not react with cold concd HNO_3 or HCl ; when heated, dissolves with evolution of CO_2 . Oxidized by air or weak oxidizing agents to cobaltic carbonate.

Hexahydrate. Pink to violet-red cryst needles. Pptd when excess CO_2 is present during prepn. On heating becomes anhydr by 140°. Stable in air.

Cobaltous carbonate basic. Cobalt carbonate hydroxide. $\text{C}_2\text{H}_6\text{Co}_3\text{O}_{12}$; mol wt 516.73. $\text{Co}_3(\text{OH})_6(\text{CO}_3)_2$. Pale-red powder, usually containing some water. Practically insol in water; sol in dilute acids and ammonia.

USE: In ceramics; manuf of Co pigments; prepn of Co compds.

THERAP CAT (VET): Nutritional factor. Used in cobalt deficiency in ruminants.

2462. Cobaltous Chloride. [7646-79-9] Cobalt dichloride. Cl_2Co ; mol wt 129.84. Cl 54.61%, Co 45.39%. CoCl_2 . Prepn of anhydr from Co powder and Cl_2 : Osthoff, West, *J. Am. Chem. Soc.* 76, 4732 (1954); from the acetate and acetyl chloride: Watt et al., *ibid.* 77, 2752 (1955); by dehydration of the hexahydrate with SOCl_2 : Hecht, *Z. Anorg. Chem.* 254, 51 (1947); prepn of the hexahydrate by treating an aqueous soln of a cobaltous salt with HCl : *Cobalt—Its Chemistry, Metallurgy, and Uses*, R. S. Young, Ed., A.C.S. Monograph Series no. 149 (Reinhold, New York, 1960) p 76. Review: de Bie, Doyen,

Cobalt 15, 3-13; 16, 3-15 (1962). Toxicity studies: G. J. A. Speijers et al., *Food Chem. Toxicol.* 20, 311 (1982); P. P. Singh, A. Y. Junnarkar, *Indian J. Pharmacol.* 23, 153 (1991). Review of toxicology: B. Venugopal, T. D. Luckey, *Environ. Qual. Safety Suppl.* 1, 4-73 (1975).

Pale-blue hygroscopic leaflets; colorless in very thin layers; turns pink on exposure to moist air. mp 735°; bp 1049°; d_4^{25} 3.367. Dec 400° on long heating in air. Sublimes at 500° in HCl gas, forming iridescent, fluffy, colorless cryst. Sol in water, alcohols, acetone, ether, glycerol, pyridine. LD₅₀ in mice, rats (mg/kg): 360.0, 171.0 orally; 92.6, 36.9 i.p.; 23.3, 4.3 i.v. (Singh, Junnarkar).

Hexahydrate. [7791-13-1] Monoclinic crystals. Structure is reported to be $[\text{CoCl}_2(\text{H}_2\text{O})_4] \cdot 2\text{H}_2\text{O}$: Mizuno et al., *J. Phys. Soc. Japan* 14, 383 (1959), C.A. 53, 14630i (1959). Pink to red, slightly deliquesce, monoclinic, prismatic crystals. mp 87°; d_4^{20} 1.924. On heating loses $4\text{H}_2\text{O}$ at 52-56° forming the dihydrate, violet or blue crystals, d_4^{25} 2.477, stable unless exposed directly to moisture. Loses another H_2O by 100°, giving monohydrate, violet, hygroscopic, amorphous solid or needles. Remaining H_2O lost at 120-140°. Sol in water, alcohols, acetone, ether, glycerol. pH of 0.2 molar aq soln 4.6. The aq soln is pink to red, but turns blue when heated or when HCl or H_2SO_4 is added. Keep well closed. LD₅₀ orally in rats: 766 mg/kg (Speijers).

Caution: Large amounts of CoCl_2 depress erythrocyte production. May lead to death in children. Other effects include cutaneous flushing, chest pains, dermatitides, tinnitus, nausea and vomiting, nerve deafness, thyroid hyperplasia, myxedema, congestive heart failure. See E. Beutler et al., *Clinical Disorders of Iron Metabolism* (Grune & Stratton, New York, 1963) pp 175-178.

USE: Invisible ink; humidity and water indicator; in hygrometers; temp indicator in grinding; in electroplating; for painting on glass and porcelain; prepn of catalysts; fertilizer and feed additive; foam stabilizer in beer; as absorbent for military poison gas and ammonia; in manuf of vitamin B₁₂. Radioactive cobalt chloride, $^{57}\text{CoCl}_2$ (half-life 271.79 days, pure gamma emitter) used in Mössbauer effect (nuclear clock).

THERAP CAT: Hematinic.

THERAP CAT (VET): Nutritional factor. Used in cobalt deficiency in ruminants.

2463. Cobaltous Chromate(III). [13455-25-9] Cobalt chromite. CoCr_2O_4 ; mol wt 226.92. Co 25.97%, Cr 45.83%, O 28.20%. Prepn: *Gmelin's, Cobalt* (8th ed.) 58, (part A), 479 (1932) and supplement, 874-876 (1961).

Brilliant greenish-blue powder having a cubic spinel structure. Almost insol in concd HCl and HNO_3 .

USE: Green pigment for ceramics.

2464. Cobaltous Cyanide. [542-84-7] Cobalt cyanide. C_3CoN_2 ; mol wt 110.97. C 21.65%, Co 53.11%, N 25.24%. Prepn: Ray, Sahu, *J. Indian Chem. Soc.* 23, 161 (1946); *Gmelin's, Cobalt* (8th ed.) 58, (part A), 364 (1932) and supplement, 712 (1961). Structure reported as $\text{Co}_3[\text{Co}(\text{CN})_6]_2$: P. S. Poskozim et al., *J. Inorg. Nucl. Chem.* 35, 687 (1973). Prepn and structure as $\text{Co}(\text{CN})_2$: D. M. S. Mosha, D. Nicholls, *Inorg. Chim. Acta* 38, 127 (1980).

Deep-blue, very hygroscopic powder. d_4^{25} 1.872.

Di- to trihydrate. Pink to reddish-brown powder or needles. Practically insol in water, acids, methyl acetate; sol in alkali cyanide solns.

USE: In cobalt catalysts.

2465. Cobaltous Fluoride. [10026-17-2] Cobalt difluoride. CoF_2 ; mol wt 96.93. Co 60.80%, F 39.20%. Prepd by the action of HF on anhydr CoCl_2 : Kwasnik in *Handbook of Preparative Inorganic Chemistry*, vol. 1, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1963) p 267; on CoCO_3 : Clark, Buchner, *J. Am. Chem. Soc.* 44, 230 (1922); on Co: Muetterties, Castle, *J. Inorg. Nucl. Chem.* 18, 148 (1961).

Rosy-red tetragonal crystals. mp 1100-1200°, forming a red liq. Volatilizes at about 1400°. d 4.43. Sparingly sol in water; readily sol in warm mineral acids. Forms di-, tri-, and tetrahydrates, all sol in water; their aq solns are dec by boiling, forming the oxyfluoride $\text{CoF}_2 \cdot \text{CoO} \cdot \text{H}_2\text{O}$.

USE: Catalyst for organic reactions.

Note: This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

USE: Catalyst; mordant for textiles.

6525. Nickel Acetylacetonate. [3264-82-2] Bis(2,4-pentanedionato-*O,O'*)nickel; bisacetylacetonatonickel(II); bis(2,4-pentanediono)nickel(II); 2,4-pentanedione nickel complex. $C_{10}H_{14}NiO_4$; mol wt 256.91. C 46.75%, H 5.49%, Ni 22.85%, O 24.91%. $Ni(CH_3COCHCOCH_3)_2$. Also $Ni(acac)_2$ or $Ni(AA)_2$. Prepn from acetylacetone and $Ni(OH)_2$: Gash, *Monatsh.* **21**, 103 (1900); from acetylacetone and $NiCl_2 \cdot 6H_2O$: Charles, Pawlikowski, *J. Phys. Chem.* **62**, 440 (1958); from 4-diethylamino-3-pentene-2-one and $NiCl_2 \cdot 6H_2O$: Gash, *Can. J. Chem.* **45**, 2109 (1967). See also Fernelius, Bryant, *Inorg. Syn.* **5**, 105 (1957). Exists as a trimer in the solid state: Bullen, *Nature* **177**, 537 (1956); Bullen *et al.*, *Inorg. Chem.* **4**, 456 (1965); as a monomer in the vapor phase: Fackler *et al.*, *J. Phys. Chem.* **72**, 4631 (1972). Structure of dihydrate: Montgomery, Lingafelter, *Acta Cryst.* **17**, 1481 (1964).

Emerald-green orthorhombic crystals. mp 229-230°. bp₁₁ 220-235°. $d^{17}_{4.4}$ 1.455. uv max ($10^{-4}M$ in $CHCl_3$): 298, 265 nm ($\log \epsilon$ 4.34, 4.44). Sol in water, alcohol, chloroform, benzene. Insol in ether, ligroin.

USE: Catalyst.

6526. Nickel Bromide. [13462-88-9] Nickel dibromide. Br_2Ni ; mol wt 218.50. Br 73.14%, Ni 26.86%. $NiBr_2$.

Trihydrate. Yellowish-green, very deliquescent crystals; loses its water at about 200°, the anhydr salt is a golden-yellow color and sublimable in absence of air. Sol in one part water, in alcohol. *Keep well closed.*

6527. Nickel Carbonate Hydroxide. [12607-70-4] $CH_4Ni_3O_7$; mol wt 304.12. C 3.95%, H 1.33%, Ni 57.90%, O 36.83%. $NiCO_3 \cdot 2Ni(OH)_2$. Tetrahydrate occurs in nature as the mineral *zaraitite*.

Tetrahydrate. Green, odorless powder. Insol in water. Sol in ammonia and in dil acids with effervescence.

USE: Nickel-plating; catalyst for hardening of fats; in ceramic colors and glazes.

6528. Nickel Carbonyl. [13463-39-3] Nickel tetracarbonyl. C_4NiO_4 ; mol wt 170.73. C 28.14%, Ni 34.38%, O 37.48%. $Ni(CO)_4$. Intermediate in nickel refining. Made by passing carbon monoxide over finely divided nickel: Mond *et al.*, *J. Chem. Soc.* **57**, 749 (1890); Gilliland, Blanchard, *Inorg. Syn.* **2**, 234 (1946). Use of nickel carbonyl in organic synthesis: G. Wilke *et al.*, *Angew. Chem. Int. Ed.* **5**, 151 (1966); M. F. Semmelhack in *Organic Reactions* vol. **19** (Wiley, New York, 1972) p 115; E. J. Corey, H. A. Kirst, *J. Am. Chem. Soc.* **94**, 667 (1972). Kinetic studies: D. H. Stedman *et al.*, *Science* **208**, 1029 (1980). Toxicity study: Hackett, Sunderman, *Arch. Environ. Health* **14**, 604 (1967). Review: Nicholls in *Comprehensive Inorganic Chemistry* vol. **3**, J. C. Bailar, Jr. *et al.*, Eds. (Pergamon Press, Oxford, 1973) pp 1115-1119.

Colorless, volatile liquid. *Poisonous!* Oxidizes in the air: explodes at about 60°. $d^{17}_{1.318}$. bp 43°. mp -19.3°. Crit temp about 200°. Crit pressure about 30 atm. Sol in about 5000 parts water free from air; sol in alcohol, benzene, chloroform, acetone, carbon tetrachloride. LD₅₀ in rats (mg/kg): 39 i.p.; 63 s.c.; 66 i.v. (Hackett, Sunderman).

Caution: Potential symptoms of overexposure are headache, vertigo; nausea, vomiting, epigastric pain; substernal pain; cough, hyperpnea; cyanosis; weakness; leukocytosis; pneumonitis; delirium; convulsions. See *NIOSH Pocket Guide to Chemical Hazards* (DHHS/NIOSH 97-140, 1997) p 222. See also *Clinical Toxicology of Commercial Products*, R. E. Gosselin *et al.*, Eds. (Williams & Wilkins, Baltimore, 5th ed., 1984) Section II, p. 145. This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

USE: In organic synthesis; production of high-purity nickel powder and continuous nickel coatings on steel and other metals.

6529. Nickel Chloride. [7718-54-9] Nickel dichloride. Cl_2Ni ; mol wt 129.60. Cl 54.71%, Ni 45.29%. $NiCl_2$. Evalu-

ation of carcinogenic risk: *IARC Monographs* **49**, 257-445 (1990).

Yellow deliquescent scales. Soly in water (g/l): 642 (20°), 876 (100°). Sol in ethanol, ammonium hydroxide. Insol in nitric acid. Sublimable in absence of air and readily absorbs NH_3 . The aq soln is acid; pH about 4. *Keep well closed.* LD₅₀ in mice, rats (mg/kg): 48, 11 i.p. (IARC).

Hexahydrate. [7791-20-0] Green, deliquescent crystals or cryst powder. Monoclinic. Structure reported to be *trans*- $[NiCl_2(H_2O)_4] \cdot 2H_2O$: Mizuno, *J. Phys. Soc. Japan* **16**, 1574 (1960), *C.A.* **55**, 26605g (1961). Sol in about one part water, in alcohol.

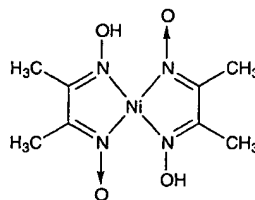
USE: Anhydr salt as absorbent for NH_3 in gas masks. Hexahydrate for nickel electroplating; manuf nickel catalysts.

6530. Nickel Cyanide. [557-19-7] C_2N_2Ni ; mol wt 110.73. C 21.69%, N 25.30%, Ni 53.01%. $Ni(CN)_2$. Prepn of yellow-brown anhydr salt: Aynsley, Campbell, *J. Chem. Soc.* **1958**, 1723. (The commercial salt usually contains 20-25% water.)

Tetrahydrate. Apple-green powder. *Poison!* Insol in water. Slightly sol in dil acids, freely in alkali cyanides, in ammonia, and in ammonium carbonate.

USE: In nickel-plating.

6531. Nickel Dimethylglyoxime. [13478-93-8] Bis[(2,3-butanedione dioximato)(1-)-*N,N'*]nickel; bis(dimethylglyoximato)nickel. $C_8H_{14}N_4NiO_4$; mol wt 288.91. C 33.26%, H 4.88%, N 19.39%, Ni 20.32%, O 22.15%. Prepn: Banks *et al.*, *J. Am. Chem. Soc.* **77**, 324 (1955); F. J. Welcher, *Organic Analytical Reagents* vol. **3** (Van Nostrand, New York, 1947) pp 165-179; Thabet *et al.*, *Inorg. Nucl. Chem. Letters* **8**, 211 (1972). Structure: Godycki, Rundle, *Acta Cryst.* **6**, 487 (1953); Merritt, *Anal. Chem.* **25**, 718 (1953).



Scarlet-red, cryst powder. Sublimes at 250°. Insol in water, acetic acid, ammonia. Sol in dil mineral acids and appreciably sol in abs alcohol.

USE: As sun-fast pigment in paints, lacquers, cellulose compounds and cosmetics.

6532. Nickel Fluoride. [10028-18-9] Nickel difluoride; nickelous fluoride. F_2Ni ; mol wt 96.69. F 39.30%, Ni 60.70%. NiF_2 . Prepn: Henkel, Klemm, *Z. Anorg. Allgem. Chem.* **222**, 74 (1935); Priest, *Inorg. Syn.* **3**, 173 (1950); Rochow, Kukin, *J. Am. Chem. Soc.* **74**, 1615 (1952); Haendler *et al.*, *ibid.* **3167**. Book: *Medical and Biological Effects of Environmental Pollutants: Nickel* (National Acad. Sci., Washington DC, 1975) 277 pp.

Yellowish to green tetragonal crystals (rutile type). d 4.72. Sublimes in HF stream above 1000°. Slightly sol in water (4 g/100 ml at 25°). Aq solns are dec by boiling. Insol in alcohol, ether. LD₅₀ i.v. in mice: 130 mg/kg (Nat. Acad. Sci.).

Caution: Chronic exposure may cause mottling of teeth, changes in bones.

6533. Nickel Formate. [3349-06-2] $C_2H_2NiO_4$; mol wt 148.73. C 16.15%, H 1.36%, Ni 39.46%, O 43.03%. $Ni(HCOO)_2$. Prepd by reaction of formic acid with Ni: Johnson, *US 2576072* (1951 to Harshaw Chemical); with $NiCO_3$: Bircumshaw, Edwards, *J. Chem. Soc.* **1950**, 1800.

Dihydrate. Fine, green, monoclinic crystals. Becomes anhydr on careful heating to 130-140°; decomposes at 180-200° yielding Ni, CO, CO_2 , H_2 , H_2O , CH_4 . $d^{20.2}_{2.154}$. Moderately sol in water. Practically insol in alc, formic acid.

USE: Manuf of Ni; prepn of Ni catalysts for organic reactions, particularly hydrogenation catalysts.

6534. Ni oxide. H_2N 34.51%. $Ni(C$ **Monohydr:** to form NiO : monia.

Note: This carcinogen: / 2000) p III-15

6535. Ni mol wt 312.5(Iron-black (bluish-green vcohol. *Keep*)

6536. Ni nickel protoxi Occurs as the Green powc

Note: This carcinogen: / 2000) p III-15 **USE:** Paint

6537. Ni 182.70. N 15. **Hexahydra** bp 137°. Sol i pH about 4. /

H. F. Smyth e **USE:** Nicke

6538. Ni 146.71. C 16. Dihydrate, l acids, in solns

6539. Ni 366.02. Ni 48 **Octahydrate** ammonia.

USE: On ig oil and water

6540. Ni black nickel (29.02%. Cont Gray-black i sol in water; v with evolution of oxygen.

6541. Ni 154.75. Ni 37 icity data: E. l Evaluation of 445 (1990); Tc 454, NIH 96-3

Hexahydrat blue to blue-g 53.3°. β -Form comes blue an somewhat eff yellow anhydr ingly sol in alc ~4.5. LD₅₀ in gan).

Heptahydra ethanol.

USE: In nic fabrics; blacke

6542. Nic tro[1,1'-biphen phenol; 5,5'-di chloropholan; B; O_6 ; mol wt 34; O 27.82%. A

2466. Cobaltous Formate. [544-18-3] $C_2H_2CoO_4$; mol wt 148.97. C 16.12%, H 1.35%, Co 39.56%, O 42.96%. $Co(HCOO)_2$. Prepn: *Gmelin's, Cobalt* (8th ed.) 58 (part A), 350 (1932) and supplement, 702 (1961).

Dihydrate. Red, cryst powder. d_4^{25} 2.13. Sol in water; almost insol in alcohol. Becomes anhydr at 140°.

USE: In prepn of Co catalysts.

2467. Cobaltous Hydroxide. [21041-93-0] CoH_2O_2 ; mol wt 92.95. Co 63.40%, H 2.17%, O 34.43%. $Co(OH)_2$. Prepd from a solution of a cobaltous salt and an alkali hydroxide: Glemser in *Handbook of Preparative Inorganic Chemistry*, vol. 2, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1965) p 1521; Weiser, Milligan, *J. Phys. Chem.* 36, 722 (1932). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Blue-green or rose-red powder or microscopic rhombohedral crystals; red form is the more stable of the two. d_4^{25} 3.597. Easily oxidized by air or weak oxidizing agents to $Co(OH)_3$. Amphoteric. Loses water on heating, forming CoO at 168° in *vacuo*. Very slightly sol in water; readily sol in acids; practically insol in dil alkalis; sol in ammonia.

USE: Manuf of Co compds; drier for paints; in enhancing drying properties of lithographic printing inks; in storage battery electrode impregnating solns.

2468. Cobaltous Iodide. [15238-00-3] Cobalt diiodide. CoI_2 ; mol wt 312.74. Co 18.84%, I 81.16%. Prepn: Clark, Buchner, *J. Am. Chem. Soc.* 44, 230 (1922); Chaigneau, *Bull. Soc. Chim. France* 1957, 886; Chaigneau, Chastagnier, *ibid.* 1958, 1192; Glemser in *Handbook of Preparative Inorganic Chemistry*, vol. 2, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1965) p 1518.

The anhydr salt exists in two isomorphous forms. α - CoI_2 : black, graphite-like solid. mp 515-520° (in high vacuum). d_4^{25} 5.584. Very hygroscopic, becomes blackish-green in air. Sol in water to give pink to red soln. β - CoI_2 : ochre-yellow powder. Blackens at 400° and converts to α -form. d_4^{25} 5.45. Very hygroscopic; deliquesces in moist air forming green droplets. Sol in water to give colorless soln which becomes pink on heating.

Hexahydrate. Dark red hexagonal prisms. Loses H_2O on heating becoming anhydr by 130°. d 2.90. Loses I_2 on exposure to air and light. Sol in water to give soln which is red below 20°, olive green at 20 to 40°, and green at higher temps. Sol in ethanol (blue soln), ether (blue to green soln), chloroform (blue soln), acetone.

USE: Indicator for moisture and humidity; determination of water in organic solvents; catalyst for organic reactions.

2469. Cobaltous Nitrate. [10141-05-6] CoN_2O_6 ; mol wt 182.94. Co 32.21%, N 15.31%, O 52.47%. $Co(NO_3)_2$. Prepn: *Gmelin's, Cobalt* (8th ed.) 58 (part A), 252-262 (1932) and supplement, 515-521 (1961); Weigel et al., *Bull. Soc. Chim. France* 1964, 836; Addison, Sutton, *J. Chem. Soc.* 1964, 5553. Toxicity study: G. J. A. Speijers et al., *Food Chem. Toxicol.* 20, 311 (1982). Review of toxicology: B. Venugopal, T. D. Luckey, *Environ. Qual. Safety Suppl.* 1, 4-73 (1975). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Pale red powder. Dec at 100-105°. d 2.49. Sol in water. LD in rabbits (mg/kg): 250 orally, 75 s.c. (Venugopal, Luckey).

Hexahydrate. [10026-22-9] Red, deliquescent, monoclinic crystals. mp ~55°. Red liq becomes green and dec to the oxide above 74°. d 1.88. Very sol in water, alcohol, most organic solvents. Keep well closed in a cool place. LD₅₀ orally in rats: 691 mg/kg (Speijers).

USE: Manuf of cobalt pigments and invisible inks; decorating stoneware and porcelain; prepn of catalysts; production of vitamin B₁₂ supplements.

2470. Cobaltous Oxalate. [814-89-1] C_2CoO_4 ; mol wt 146.95. C 16.35%, Co 40.10%, O 43.55%. CoC_2O_4 . Prepn: Robin, *Bull. Soc. Chim. France* 1953, 1078; *Gmelin's, Cobalt* (8th ed.) 58 (part A) p 355 (1932) and supplement, pp 704-706 (1961). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

d_4^{25} 3.021. Readily absorbs moisture from air to form hydrates.

Dihydrate. Light pink microcryst powder or needles. Almost insol in water; slightly sol in acids; almost insol in aq

oxalic acid; freely sol in aq ammonia. Dec on heating with aq KOH or Na_2CO_3 soln.

Tetrahydrate. Yellowish-pink amorphous powder. Effloresces on exposure to air. Loses water on heating to 100° giving the dihydrate. Very slightly sol in water; slightly sol in acids; readily sol in aq ammonia.

USE: Prepn of Co catalysts, Co metal powder for powder-metallurgical applications; stabilizer for HCN; temperature indicator.

2471. Cobaltous Oxide. [1307-96-6] CoO ; mol wt 74.93. Co 78.65%, O 21.35%. Prepn: Amiel et al., *Compt. Rend.* 259, 3512 (1964); Wilke, *Z. Anorg. Allgem. Chem.* 330, 164 (1964). Toxicity study: Smyth et al., *Am. Ind. Hyg. Assoc. J.* 30, 470 (1969). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Powder, or cubic or hexagonal crystals. Color varies from olive green to red, depending on the particle size, but the commercial material is usually dark grey and contains about 76% Co. mp ~1935°. d 5.7 to 6.7, depending on method of prepn. Readily absorbs O_2 even at room temp. Practically insol in water. Sol in acids or alkalies. Easily reduced to Co by C or CO. Reacts at high temperatures with silica, alumina, zinc oxide to form pigments. LD₅₀ orally in rats: 1.70 g/kg (Smyth).

Note: The commercial oxides are usually not definite chemical compds but mixtures of the cobalt oxides.

USE: In pigments for ceramics; glass coloring and decolorization; oxidation catalyst for drying oils, fast-drying paints and varnishes; prepn of cobalt-metal catalysts, Co powder for binder in sintered tungsten carbide; in semiconductors.

2472. Cobaltous Phosphate. [13455-36-2] C.I. Pigment Violet 14; C.I. 77360. $Co_3O_8P_2$; mol wt 366.74. Co 48.21%, O 34.90%, P 16.89%. $Co_3(PO_4)_2$. Prepn from $CoCl_2$ and $(NH_4)_2HPO_4$: Klement, Haselbeck, *Z. Anorg. Allgem. Chem.* 334, 27 (1964); from $Ca(H_2PO_4)_2$: Vickery, US 2914380 (1959 to Horizons). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962). See also *Colour Index* vol. 4 (3rd ed., 1971) p 4665.

Octahydrate. Pink to lavender amorph powder. d 2.77. Practically insol in water; sol in mineral acids.

USE: In ceramic pigments; in artists' colors, plastic resins.

2473. Cobaltous Sulfate. [10124-43-3] CoO_4S ; mol wt 154.99. Co 38.02%, O 41.29%, S 20.69%. $CoSO_4$. Hexahydrate occurs in nature as the mineral *bieberite*. Prepn: Clark et al., *J. Am. Chem. Soc.* 42, 2483 (1920); Hammel, *Ann. Chim.* 11, 247 (1939); *Gmelin's, Cobalt* (8th ed.) 58, (part A) 324-336 (1932) and supplement, 628-647 (1961). Review: de Bie, Doyen, *Cobalt* 15, 3-13; 16, 3-15 (1962).

Red to lavender dimorphic, orthorhombic crystals. d_4^{25} 3.71. Stable to 708°. Dissolves slowly in boiling water.

Monohydrate. Rose-colored, monoclinic crystals. Structure reported to be $Co(H_2SO_5)$. d_4^{25} 3.08. Dissolves slowly in boiling water.

Heptahydrate. Structure reported to be $[Co(H_2O)_6][H_2SO_5]$. Pink to red monoclinic, prismatic crystals. On heating dehydrates to the hexahydrate (monoclinic, prismatic crystals) at 41.5°, and to the monohydrate at 71°. d_4^{25} 2.03. Sol in water; slightly sol in methanol, ethanol.

USE: Usual source of water-soluble cobalt since it is the most economical and it shows less tendency to deliquesce or dehydrate than the chloride or nitrate. Used in storage batteries; in Co-electroplating baths; as drier for lithographic inks, varnishes; in ceramics, enamels, glazes to prevent discoloring; in Co pigments for decorating porcelain.

2474. Cobaltous Sulfide. [1317-42-6] CoS ; mol wt 91.00. Co 64.76%, S 35.24%. Prepn: Glemser in *Handbook of Preparative Inorganic Chemistry*, vol. 2, G. Brauer, Ed. (Academic Press, New York, 2nd ed., 1965) p 1523.

Exists in two forms. α - CoS : black, amorphous powder. Forms $Co(OH)S$ in air. Sol in HCl. β - CoS : grey powder or reddish-silver octahedral crystals. mp >1100°; d 5.45. Practically insol in water; sol in acids.

USE: Catalyst for hydrogenation or hydrodesulfurization.

2475. Cobaltous Thiocyanate. [3017-60-5] Cobaltous rhodanide; cobaltous sulfocyanate. $C_2CoN_2S_2$; mol wt 175.10.

C 13.72%
Prepn: G
suppleme
tory Prep
Yellow-
colored sc
give blue
Trihyd
transmitter
pink on dil
USE: A

2476.
sine-5') de
(ester) wit
ole, inner s
B₁₂; 5'-dec
bencozide;
benzimidaz
olylcobami
timide; Ade
Cobanzyme
Héracène;
Xobaline. (C
6.38%, Co :
zyme is the
et al., Proc.
Taylor, Vita
culture of P
Chem. 235,
Prepn of aqu
lylsulfonylad
from treatme
US 3461114
from Vitamin
in the axial
Structure: Le
cleoside is li
deoxyribosyl
reside in this
240, 3641 (1
Smith, Vitami

H₂N-

H₂N-

H₂N-

BEST AVAILABLE COPY

is 49, 257-445

g/l): 642 (20°),
e. Insol in nitric
/ absorbs NH₃,
d. LD₅₀ in mice,

sc crystals or
d to be trans-
apan 16, 1574
ie part water, in

s masks. Hexa-
catalysts.

N₂Ni; mol wt
CN)₂. Prepn of
J. Chem. Soc.
ins 20-25% wa-

! Insol in water.
s, in ammonia,

93-8] Bis[(2,3-
dimethylglyoxi-
C 33.26%, H
n: Banks et al.,
r, *Organic An-*
York, 1947) pp
s 8, 211 (1972).
(1953); Merritt.

Insol in water,
and appreciably

, cellulose com-

ckel difluoride;
9%, Ni 60.70%.
m. Chem. 222,
chow, Kulin, J.
al., *ibid.* 3167.
ronmental Pol-
DC, 1975) 277

: type). d 4.72.
sol in water (4
insol in alcohol,
1. Sci.).
ntling of teeth,

I₂NiO₄; mol wt
6, O 43.03%.
with Ni: John-
); with NiCO₃:
20.

s. Becomes an-
ses at 180-200°
54. Moderately
d.
or organic reac-

6534. Nickel Hydroxide. [12054-48-7] "Green nickel oxide". H₂NiO₂; mol wt 92.71. H 2.17%, Ni 63.31%, O 34.51%. Ni(OH)₂.

Monohydrate. Apple-green powder. Decomp above 200° to form NiO and H₂O. Insol in water. Sol in dil acids, in ammonia.

Note: This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

6535. Nickel Iodide. [13462-90-3] Nickel diiodide. I₂Ni; mol wt 312.50. I 81.22%, Ni 18.78%. NiI₂.

Iron-black color. Sublimes in absence of air. Hexahydrate, bluish-green very deliquescent crystals. Very sol in water or alcohol. *Keep well closed.*

6536. Nickel Monoxide. [1313-99-1] Nickelous oxide; nickel protoxide. NiO; mol wt 74.69. Ni 78.58%, O 21.42%. Occurs as the mineral *bunsenite*.

Green powder; yellow when hot. Insol in water. Sol in acids.

Note: This substance is reasonably anticipated to be a human carcinogen: *Ninth Report on Carcinogens* (PB2000-107509, 2000) p III-155.

USE: Painting on porcelain.

6537. Nickel Nitrate. [13138-45-9] N₂NiO₆; mol wt 182.70. N 15.33%, Ni 32.13%, O 52.54%. Ni(NO₃)₂.

Hexahydrate. Green, deliquescent crystals. d 2.05. mp 56.7°. bp 137°. Sol in 0.4 part water, in alcohol. The aq soln is acid; pH about 4. *Keep well closed.* LD₅₀ orally in rats: 1.62 g/kg. H. F. Smyth et al., *Am. Ind. Hyg. Assoc. J.* 30, 470 (1969).

USE: Nickel-plating; manuf brown ceramic colors.

6538. Nickel Oxalate. [547-67-1] C₂NiO₄; mol wt 146.71. C 16.37%, Ni 40.01%, O 43.62%. NiC₂O₄.

Dihydrate, light green powder. Insol in water; sol in mineral acids, in solns of ammonium chloride, nitrate, or sulfate.

6539. Nickel Phosphate. [10381-36-9] Ni₃O₈P₂; mol wt 366.02. Ni 48.11%, O 34.97%, P 16.92%. Ni₃(PO₄)₂.

Octahydrate, light green powder. Insol in water; sol in acids, ammonia.

USE: On ignition yields "nickel yellow"—a pigment used in oil and water colors.

6540. Nickel Sesquioxide. [1314-06-3] Nickelic oxide; black nickel oxide. Ni₂O₃; mol wt 165.39. Ni 70.98%, O 29.02%. Contains a variable quantity of water.

Gray-black powder. Dec at ~600° into NiO and oxygen. Insol in water; very slightly sol in cold acid; dissolved by hot HCl with evolution of Cl, and by hot H₂SO₄ or HNO₃ with evolution of oxygen.

6541. Nickel Sulfate. [7786-81-4] NiO₄S; mol wt 154.75. Ni 37.93%, O 41.35%, S 20.72%. NiSO₄. Acute toxicity data: E. L. Reagan, *J. Am. Coll. Toxicol.* 1, 685 (1992). Evaluation of carcinogenic risk: *IARC Monographs* 49, 257-445 (1990); *Toxicology and Carcinogenesis Studies* (NTP TR-454, NIH 96-3370, 1996) 379 pp.

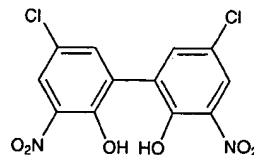
Hexahydrate. [10101-97-0] Two known phases. α-Form, blue to blue-green tetragonal crystals; transition to β-form at 53.3°. β-Form, green transparent crystals; stable at 40°; becomes blue and opaque at room temp. Sweet astringent taste; somewhat efflorescent. Loses 5H₂O at ~100°. Greenish-yellow anhydrous salt formed at 280°. Sol in 1.4 parts water; sparingly sol in alcohol, more in methanol. The aq soln is acid; pH ~4.5. LD₅₀ in male, female rats (mg/kg): 335, 264 orally (Reagan).

Heptahydrate. [10101-98-1] Green crystals. Sol in water, ethanol.

USE: In nickel-plating; as mordant in dyeing and printing fabrics; blackening zinc and brass.

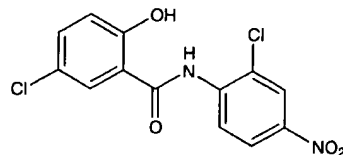
6542. Niclofolan. [10331-57-4] 5,5'-Dichloro-3,3'-dinitro[1,1'-biphenyl]-2,2'-diol; 4,4'-dichloro-6,6'-dinitro-*o,o'*-biphenol; 5,5'-dichloro-2,2'-dihydroxy-3,3'-dinitrobiphenyl; menichlopholan; Bayer 9015; ME-3625; Bilevon-M. C₁₂H₆Cl₂N₂O₆; mol wt 345.09. C 41.77%, H 1.75%, Cl 20.55%, N 8.12%, O 27.82%. Anthelmintic activity: Meiser, Federmann, US

3082151 (1963 to Bayer); P. J. Lane, J. M. Stewart, *Vet. Rec.* 80, 702 (1967). Pharmacokinetics in desert sheep: B. H. Ali et al., *J. Vet. Pharmacol. Ther.* 13, 217 (1990).



THERAP CAT (VET): Anthelmintic (fasciolicide).

6543. Niclosamide. [50-65-7] 5-Chloro-N-(2-chloro-4-nitrophenyl)-2-hydroxybenzamide; 2',5-dichloro-4'-nitrosalicylanilide; 5-chloro-N-(2'-chloro-4'-nitrophenyl)salicylamide; 5-chlorosalicyloyl-(*o*-chloro-*p*-nitranilide); N-(2'-chloro-4'-nitrophenyl)-5-chlorosalicylamide; Bayer 2353; Cestocide; Niclo-cide; Ruby; Trédémine; Yomesan. C₁₃H₈Cl₂N₂O₄; mol wt 327.12. C 47.73%, H 2.47%, Cl 21.68%, N 8.56%, O 19.56%. Prepn: **GB 824345** (1959 to Bayer), *C.A.* 54, 15822b (1960). See also: E. Schraufstätter, R. Gönner, **US 3079297**; R. Strufe et al., **US 3113067** (both 1963 to Bayer); Bekhli et al., *Med. Prom. SSSR* 1965, 25.



Pale yellow crystals, mp 225-230°. Practically insol in water. Sparingly sol in ethanol, chloroform, ether.

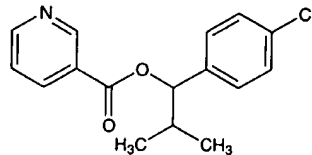
Ethanolamine salt. [1420-04-8] Clonitride; Bayluscid. C₁₃H₈Cl₂N₂O₄·C₂H₇NO; mol wt 388.21. Yellow-brown solid, mp 204°.

USE: The ethanolamine salt as a molluscicide.

THERAP CAT: Anthelmintic (Cestodes).

THERAP CAT (VET): Anthelmintic (Cestodes).

6544. Nicoclonate. [10571-59-2] 3-Pyridinecarboxylic acid 1-(4-chlorophenyl)-2-methylpropyl ester; nicotinic acid *p*-chloro- α -isopropylbenzyl ester; 1-(*p*-chlorophenyl)isobutyl nicotinate; *p*-chlorophenylisopropylcarbinol nicotinate; 1-(*p*-chlorophenyl)-1-(nicotinoyloxy)-2-methylpropane; S-486; Lipidium. C₁₆H₁₆ClNO₂; mol wt 289.76. C 66.32%, H 5.57%, Cl 12.24%, N 4.83%, O 11.04%. Prepn: J. Nordmann, H. B. Swierkot, **FR M3454**; *idem*, **US 3367939** (1965, 1968 both to Kuhlmann).



Base, white needles from methanol and water, mp 61-62° (Maquenne block); 55-56.5° (Culatti block). Very soluble in lipids; sol in alcohols, benzene, toluene, ether and acetone. Practically insol in water.

Hydrochloride. C₁₆H₁₇Cl₂NO₂. Crystals from methanol, mp 124-127°C. LD₅₀ i.p. in mice: 2.27 g/kg (Nordmann, Swierkot).

THERAP CAT: Antilipemic.

6545. Nicofuranose. [15351-13-0] β -D-Fructofuranose 1,3,4,6-tetra-3-pyridinecarboxylate; fructose 1,3,4,6-tetranicotinate; 1,3,4,6-tetranicotinoylfructofuranose; 1,3,4,6-tetranicotinoyl-D-fructose; Vasperdil; Bradilan. C₃₀H₂₄N₄O₁₀; mol wt